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ELECTRIC RAILWAYS

How They Are Operated

NO VEHICLE HAS BEEN FOUND WHICH WILL TAKE THE PLACE OF THE MODERN STREET CAR FOR EFFICIENTLY CARRYING LARGE NUMBERS OF PEOPLE THROUGH THE CONGESTED TRAFFIC OF BIG CITIES.

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ELECTRIC TRANSPORTATION

THE STORY of the electric railways is an interesting chapter in American progress. It is a tale of how inventors, builders, financiers, managers and operating organizations composing thousands of men and women have overcome countless obstacles in order to provide the public with safe, rapid and economical transportation.

Because they fill a *public need* and are obligated to carry any person who will pay the rate of fare fixed by public authorities, electric railways are known as public or common carriers.

Electric railways provide two forms of service. First, there are those companies which provide only service within cities or between them and immediately adjacent suburbs. They are known as *local transportation* companies. Second, there are electric interurban railroads which provide service over long distances, serving many communities and the country between them.

The Horse Car:

When cities were small, people provided their own transportation. They either walked, rode a bicycle or maintained a horse.

As cities grew and distances became greater between work, business and the home, the time in getting about necessitated both a speedier and cheaper form of transportation. It was found that several people might "club" together and provide a transportation service. The result was that stages and other forms of horse-drawn vehicles became common.

But the growth of cities was very rapid and American ingenuity attempted to solve the transportation problem of handling large numbers of people through use of the horse car. While this form of transportation would be crude today, it was a big advance over previous transportation and paved the way to our great electric systems of today.

The first horse-drawn car, the "John Mason," commenced operations in New York City about 1828. The car resembled an omnibus. It was pulled by a team of horses over strap iron rails laid on stone ties. It was the first street railway for carrying passengers.

Horse cars were small and unheated; kerosene lanterns provided illumination; and in winter the floors were covered with straw so passengers could keep their feet warm.

One horse, or more often a mule, hauled the smaller cars. As larger cars were built, two horses or mules were required. By their constant tramping over city streets, the horses wore out the pavements, so city councils required the street car companies to repair and maintain the pavement along their routes. While it has been many years since horse cars have been seen on the streets of modern cities, this requirement to maintain pavement is in most franchises to this day.

The urge for faster and more economical transportation caused inventors to work on the problem of supplanting the horse with mechanical power. In a later day was to come the electric, or *trolley,* car which went much faster than the horse car.

Early Inventors:

However, before the fast, comfortable street cars of today were finally evolved, numerous men struggled and worked tirelessly and patiently to make electric transportation available. The early history of electric transportation abounds in incidents of futile and unrewarded knowledge. Beginning with no technical knowledge—the best universities of the world could give them none—the pioneers in the field groped forward. A life of such labor too frequently brought no results. But here and there a mite of knowledge was added to the meager store.

The first step was taken in 1821 when Faraday discovered that electricity could be used to produce mechanical motion. Eleven years later Henry invented the first electric motor and three years later Davenport found that electricity could be made to drive a car along rails.

Thomas Davenport, a country blacksmith of Brandon, Vermont, is an example of those heroic pioneers whose work was practically futile, although America owes him a great honor. He was poor and uneducated, but in six years he made a hundred electric motors and at last, in 1835, operated a small circular electric railway at Springfield, Massachusetts.

IN ILLINOIS

ILLINOIS LEADS THE NATION IN THE DEVELOPMENT OF ITS ELECTRIC RAILWAY SYSTEMS, IT HAVING—

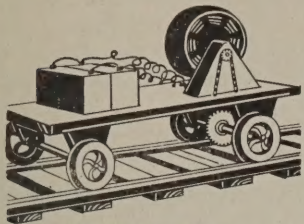
THE ELECTRIC STREET RAILWAY HAVING THE GREATEST MILEAGE OF ANY SYSTEM IN THE WORLD—THE CHICAGO SURFACE LINES.

THE LARGEST INTERURBAN ELECTRIC RAILWAY SYSTEM IN THE WORLD—THE ILLINOIS TERMINAL RAILROAD SYSTEM.

THE LARGEST FLEET OF TRACKLESS TROLLEY BUSES IN THE WORLD, OPERATED BY THE CHICAGO SURFACE LINES.

THE THREE FASTEST ELECTRIC INTERURBAN RAILROADS IN THE UNITED STATES, THE CHICAGO NORTH SHORE & MILWAUKEE RAILROAD, THE CHICAGO SOUTH SHORE & SOUTH BEND RAILROAD AND THE CHICAGO AURORA & ELGIN RAILROAD.

His car was driven by batteries which it carried. His principle was wrong, and beyond giving the world an idea, his work was fruitless.



DAVENPORT'S CAR

Next came Robert Davidson of Aberdeen, a Scotsman. In 1838 he took from America the honor of producing the first electric car to move on a standard gauge track. As early as 1841 the idea of using rails as current conductors was patented by Henry Pinkus. In 1855, an Englishman, trying to bring about telegraphic communications with moving trains, gave us in its first form what is today the *trolley wire* and *trolley pole*. In 1861, Pacinnoti, in Europe, invented the reversible continuous current dynamo. Modern generators are founded on this principle.

The invention of the dynamo, which changes mechanical energy into electricity, opened the path to successful electric railways. It was a brilliant climax to the twenty-six years that elapsed between the inventions of Davenport and Pacinnoti. Before the dynamo, inventors were obliged to demonstrate their ideas with electricity obtained from batteries. Because of the expense, this precluded possibility of commercial success.

While all of the underlying principles of electric railway operation were known in 1861, it was not until 1879 that the first practical line was built, and nine more years elapsed before electric railways were constructed for commercial use. The chief difficulty was obtaining a satisfactory supply of electricity. That so much time elapsed, indicates the difficulty of the task.

The Cable Car:

While inventors were working toward, and solving, the problem of applying electric energy to transportation, the *cable car* intervened, and rapidly supplanted the horse car.

The cable car was first introduced in August, 1873, in San Francisco. The basic idea had been suggested previous to this time by E. S. Gardiner of Philadelphia, but the commercial application was due to the pioneering of Andrew S. Hallidie and his associates, Ash E. Hevey, William Eppelsheimer and Henry Root.

The new system consisted of a long steel cable, travelling in an underground slot, between the rails. The cable was propelled by steam power houses located every few miles along the car routes. Each car was provided with a *grip* which extended down into the slot. The motorman—then called the gripman—attached the grip to the moving cable to move the car. To stop the car, he freed the grip from the cable and applied the brakes.

Where hills are steep and car wheels tend to slip on rails, cable cars are still used. None are now used in Illinois.

The first cable cars in Illinois were put in operation in Chicago on January 28, 1882.

Cable cars were popular for about 25 years, when they were displaced by electric street cars. Having a speed of eight miles per hour, cable cars were faster than horse cars, but frequent breakdowns, and the rapid increase of population in cities, made it apparent that a different vehicle was needed for local transportation.

Inventors pursued a study of electricity believing that in this power lay the future of street railway transportation.

Origin of Trolley Car:

In the late '70's claims for patents on electric railways were filed by three men. Two were Americans, Thomas A. Edison and Stephen D. Field. To the third man, Siemens, a German, goes the honor of having operated the first practical electric railway line. This was at the great Berlin Exposition of 1879. In America, Field, first to file his patent, put his line in service in 1880.

The next year, a line, one and one-half miles long, was operated at Lichterfelde, near Berlin, Germany. The car carried 36 people at the speed of 30 miles an hour. In the same year, between Charlottenburg and Spandau, the first effort was made to compete with horse-drawn street cars.

The first exhibitions of electric traction in the American western states were by Charles J. VanDepoele, a Belgian sculptor and inventor, who actually drew current from an overhead wire at the Industrial Exposition in Chicago in 1883; and by Edison and Field, who operated a small electric locomotive at the Railway Exposition in the same city the same year.

America's first practical electric line was operated in Cleveland in 1884, when Bentley and Knight equipped a two-mile track of the East

HORSES PROVIDED THE MOTIVE POWER FOR THE FIRST STREET CARS.

Cleveland Railway for electric operation, electricity for the cars being taken from a wire laid in a conduit between the rails.

In the same year, John C. Henry built a line in Kansas City. Henry's line gave us the trolley pole and the word *trolley*, a corruption of the word *troller*, which was a little four-wheeled carriage that ran along the overhead wire and transmitted electricity through a flexible cable to the car. People called this little carriage a *trolley*, and later called the car it propelled a *trolley car*. Before the introduction of the trolley pole it was necessary to have a small boy ride on the top of each car to keep the trolley in contact with the wire. Henry conquered great obstacles to get his line in operation. Copper wire for the trolley line could be obtained only in sixty-foot lengths and he had to use horseshoe nails to bond the rails of his line.

TROLLEY WHEEL.

Electric railways, as we know them today, received their start in a line built by Frank J. Sprague at Richmond, Virginia. Service started on his line February 2, 1888. Although short lines were in operation in Cleveland and Kansas City, public attention centered on Sprague's line, which first showed the commercial possibilities of electric transportation.

Sprague "Father" of Industry:

Sprague is generally called the "father" of electric railways. Much of his success is attributed to his having technical training, an asset which other pioneers lacked. Although he demonstrated what electric railways could do, and he was able to raise money to finance his projects, his accomplishments were not without difficulties.

Before building the line in Richmond, Sprague, in company with Leo Daft and others, had tried to convince officials of the elevated railway lines in New York City that electricity would provide faster and better operation than steam locomotives, which were then used. Failing to persuade the officials to make the change, Sprague turned to Richmond, and founded the Sprague Electric Railway and Motor Company.

This company started with 40 cars which were equipped with electric motors. All other lines in America combined had only 50 cars so equipped. The entire world had only 19 electric railways, and ten of these were in the United States.

Sprague's confidence in electric railways was justified by subsequent developments. Within twelve months after the start of the line in Richmond, there were 50 electric lines operating in the United States. These comprised 100 miles of track.

In 1890, two years after the start of the line in Richmond, there were 1,262 miles of electric railway tracks in America. There were fewer than 3,000 cars at the same time.

Increased Riding:

Less than half a century later, in 1930, local transportation needs of the people of the United States required about 37,000 miles of track, over which were operated almost 90,000 cars. Electric railway tracks now in use would go around the earth about one and one-half times.

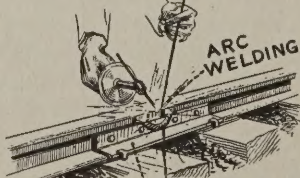
The public's needs have necessitated constantly increasing service. In 1890 the people of the United States averaged 32 rides each on electric railways; in 1907 this average was 85 rides; in 1928 it was 104 rides; and in 1930 each person averaged 117 rides. These figures include the entire population of the country, many of whom live in areas that do not have electric railway service. Therefore, it is seen that residents of areas having electric railway service average more rides per year than is shown in the foregoing figures.

While the *basic principles* of electric railway operation are today much the same as they were when Sprague put his first line into operation, there have been many improvements and refinements, and the early cars would today be laughed at by those who are familiar with modern systems.

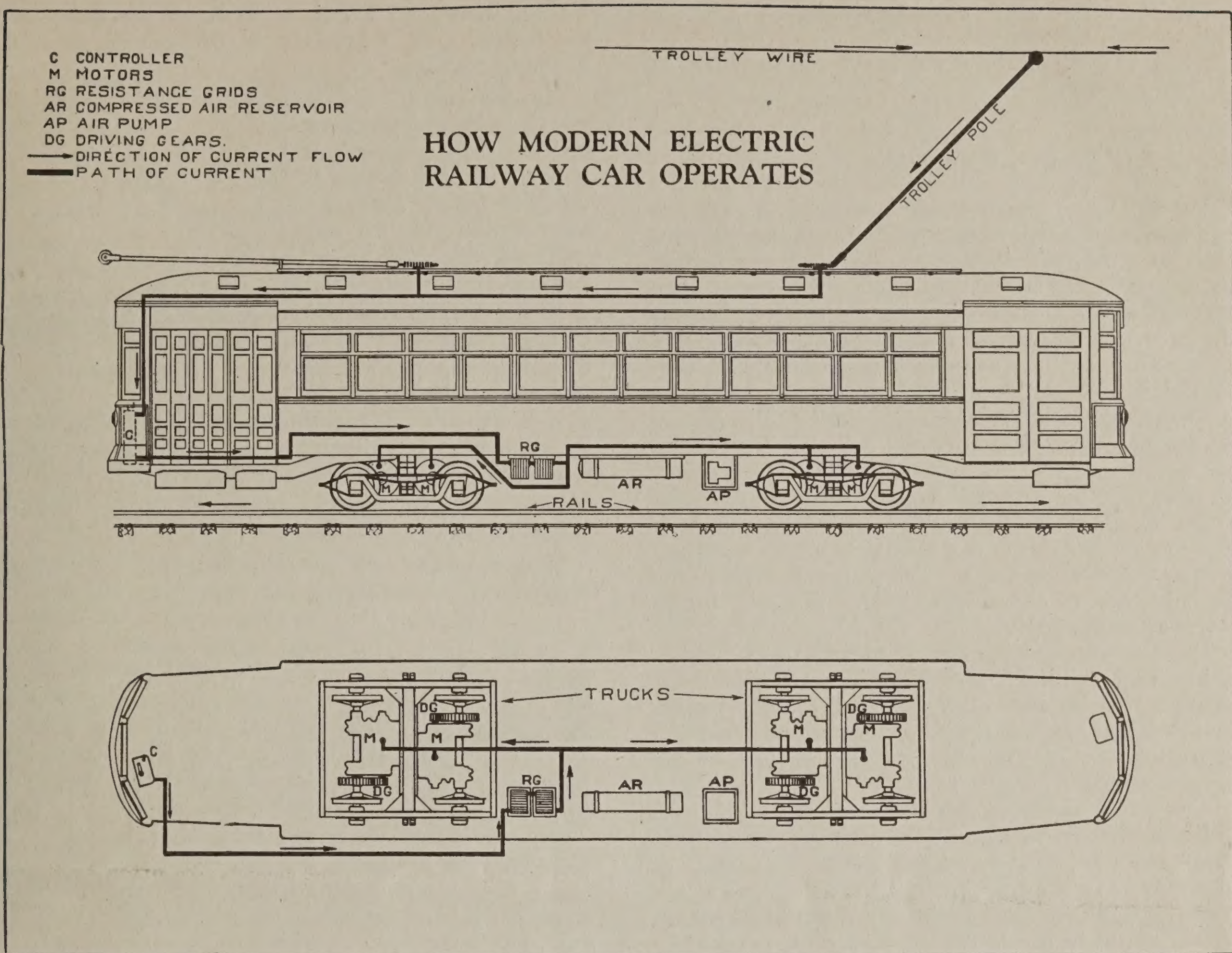
Tracks in the streets are a familiar sight. So are the long rows of poles on the sides of the street, and the shiny copper wire that is hung directly over the tracks. When cars pass sparks and flashes are often seen along the rails under the car wheels and along the trolley wire, where the trolley passes. In stormy weather, these flashes are often brilliant blue and yellow, giving evidence of electricity passing from the wire down the trolley pole to the electric motors which turn the wheels.

People naturally wonder what this energy looks like; how it acts and where it goes. No one ever saw electric current; but a scientist, Michael Faraday, noticed that when electricity passed through a wire it moved a nearby magnet sideways, and that when the magnet was changed to the other side of the wire it moved in a different direction.

Faraday arranged the magnet so that it rotated around a shaft; and then, instead of one wire and one magnet, he added many more about the shaft, and produced a rotating motor. This is the electric motor that turns the wheels of a street car—a motor which, though very intricate, is so compact that it can be built into the truck of an electric railway car.



TO ASSURE A COMPLETE ELECTRIC CIRCUIT, RAILS ARE "BONDED" TOGETHER AT THE JOINTS WITH COPPER WIRES. THE WIRES ARE ELECTRICALLY WELDED TO THE STEEL RAILS.



Electricity Supply:

Where does the current go? Persons noticing the sparks between car wheels and the rails have probably guessed, correctly, that the electric current passes down the trolley pole, through an insulated wire to the motors, where it accomplishes the work of moving the car, and thence flows through the rails and auxiliary circuits to the power house. Thus, the current has completed a loop, or circuit, which is necessary for electricity to do its work.

No electric shock is received by standing on the rail carrying the current back to the power house because the rail in itself is not a completed circuit. Touching the trolley wire and the track at the same time would complete the circuit and cause a shock.

Linemen are careful, while working on charged, or "live," wire that their bodies do not form a path to the ground for the current. Protective devices, such as insulated platforms, rubber gloves, etc., interrupt the circuit through which the current would otherwise be carried. A bird alighting on a charged wire does not receive a shock because it is in contact with only one side of the circuit.

It is seen that when an electric circuit is opened, thus breaking the flow of electricity, the current can do no work. When the circuit is closed, electricity flows, and does its work.

For opening and closing the circuits on an electric railway car, the motorman is provided with a controller. To start the car he moves the handle on the controller, which closes the circuit. But the controller is constructed so that the electricity is supplied gradually to the motors, only a little at first. If the immense power available from the trolley wire were applied suddenly, it would cause the motors to spin the car wheels, like those on a steam locomotive whose engineer has opened the steam throttle too wide.

The first slight turn, or notch, on the controller completes the electric circuit, allowing the current to flow and start the motor, but, before the current enters the motor it is led through a number of thin iron grids of such composition as to offer a large resistance to the passage of the electricity, and therefore lets only a small quantity reach the motors. The next slight turn of the controller eliminates some of this resistance, permitting more electricity to reach the motors. As the controller is turned, notch at a time, the amount of resistance offered the current is lessened until, at the last

notch, the resistance is entirely eliminated, and the full force of the current from the trolley wire flows directly to the motors, causing the car to travel at its highest speed.

How Air Brakes Operate:

Practically all modern electric railway cars are equipped with air brakes, which are similar in principle to those used to stop the heaviest and fastest steam passenger trains. In the early days of electric railways, brakes were hand-operated, but as the cars became heavier and faster air brakes were substituted, as they are much more powerful, certain and safe.

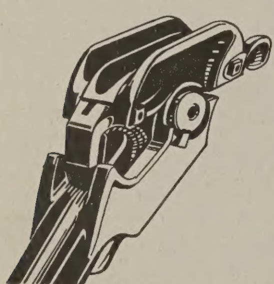
Compressed air for the operation of the brakes is obtained from a compressor, which is driven by an electric motor. The air is stored in a tank, or reservoir, and is available for instant use. The brake mechanism is located underneath the floor of the car, and often the pump is heard compressing air even after the car has stopped. Whenever the pressure in the reservoir gets low, the pump starts automatically.

Passage of air from the reservoir to the mechanism that applies the brakes is controlled by a valve, which is seen at the right hand of the motorman. This air valve is constructed so that the motorman can easily regulate the amount of air applied to the brakes.

From this valve the air flows to the brake cylinder, and from this point the operation is simple. The brake cylinder is perhaps 8 to 14 inches in diameter. It is fitted with a piston. As the air enters one end of the cylinder, it forces this piston slowly ahead of it. If the air is at a pressure of 70 pounds per square inch, and the piston is 14 inches in diameter, a force of 14,000 pounds is exerted—70 pounds on each square inch of the piston. This force of 14,000 pounds is multiplied many times by levers, and the resultant power forces the iron brake shoes against the car wheels and thus brings the car to a stop.

Contact Systems:

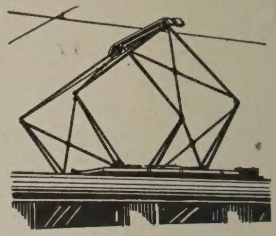
Thus far, only the *basic principles* of electric railway cars have been considered. Although these principles are fundamental to all electric railways, their application varies to meet different conditions. For example, four different "contact" devices are now in use for obtaining the current necessary to run the cars.



TROLLEY SHOE.

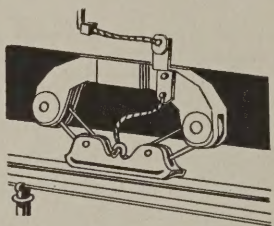
Some lines do not use the *trolley wheel,* but instead use the *trolley shoe,* which slides instead of rolls along the trolley wire. It has been found that with the shoe there is less arcing—flashing of brilliant light—than when the wheel is used. With the shoe, the trolley wire is greased to reduce friction, and to lessen arcing.

Many high-speed interurban electric railroads use the *pantagraph* instead of the trolley wheel and pole. The pantagraph is a flexible metal framework surmounted by a metal cross bar. Springs hold the framework in place, and give the metal cross bar a strong, upward thrust, forcing it against the trolley wire. Even at high speeds it has been found that the pantagraph maintains a good contact with the trolley wire, eliminates the tendency sometimes found with a trolley wheel or shoe to jump off the wire, and reduces arcing to a minimum.



PANTAGRAPH.

Where conditions permit, the *third rail* has proved very satisfactory for supplying electricity to moving cars. Instead of an overhead trolley wire, an insulated steel rail is constructed parallel to and at one side of the tracks. On the cars are iron shoes which slide along this third rail, drawing electricity for the motors. This system has the advantage of not requiring overhead construction to support trolley wires, and seldom gets out of order.



THIRD RAIL SHOE.

Electric railway systems are large users of electricity. To start an ordinary street car requires 1,000 times as much electricity as is used to burn a 60-watt electric lamp, or run a household electric fan. In the cold days of winter, to heat a car with electricity takes from 25 to 50 per cent as much electricity as it does to move it.

In the early years of electric railways, most companies generated their own electricity, but in recent times, with electric light and power companies having large quantities of electricity available along the railway routes, it has been found to be more economical to purchase power.

However, as street railways use only direct current, and power companies generally have only alternating current available, it is necessary to use converters, or rectifiers, to change the electricity from alternating to direct current.

In explaining the progress made, and success enjoyed by the electric railway industry in transporting masses of people quickly and with minimum delay, no small amount of credit is due to the efficiency of the electric motor.

The electric motor is vastly more efficient than the finest steam plant or gasoline engine.

Local Transportation Systems:

Local transportation systems are public carriers which serve a single city, or two or more cities which are adjacent and whose interests are so merged that they are, in reality, one big community.

Most local transportation systems started as electric street car lines, or, if they are very old, as horse car or cable car lines. At the present time, local transportation systems use electric street cars for the heavy traffic in large cities, but in some smaller cities, and in the sparsely settled parts of the large cities, gasoline motor coaches (or buses) and electric trackless trolley cars are used as auxiliaries to the street cars.

The heavy-duty street car (as pictured on the cover) is the car relied on for moving large numbers of people in centers of population. Where there is less traffic, and the crowds are smaller, the "safety car" is in common use.

Transportation Sets Land Values:

According to zoning and real estate authorities, the value of land depends upon its transportation facilities. It is valuable only to the extent to which it can be used and is accessible.

For many years there has been a tendency for big cities to decentralize, or spread out, into a metropolitan district. The area of this district is not measured in miles from the center of the business or shopping district: it is measured by the maximum time which people will spend in travel.

This decentralization makes it possible for people of moderate means to acquire a home with enough ground for children to play, and for a garden, while retaining their employment or business in a congested city.

As transportation makes this decentralization possible, it is important that transportation facilities be provided in step with, and in advance of, the growth of a metropolitan district.

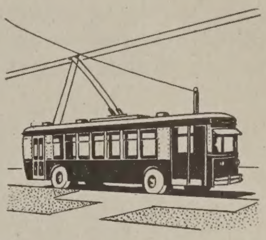
Following a traffic survey of fifteen large American cities, Harvard University predicts that big cities of the future will be composed, chiefly, of large, self-sufficing skyscrapers, containing all essentials to urban life, such as hotels, banks, shops and other varied interests. Stations for rapid transit lines—elevated and subways—will be a part of these buildings, so that occupants will have direct access to transportation.

The importance of adequate transportation is shown by the increased reliance being placed upon public carriers. In the last half century the use of electric railways in the United States had increased approximately six times as fast as the population.

Trackless Trolley Car:

The newest type of electric car in Illinois is the trackless trolley car. It is used in Chicago, Rockford and Peoria, and interest has been shown by other Illinois local transportation systems.

Like the motor coach it is a rubber-tired vehicle and runs over paved streets. It has electric motors of the street car type, and like the street car obtains electric power from overhead wires. It has two trolleys, each running along its own wire, for since the trolley-bus does not run on rails, the second trolley and trolley-wire are necessary to return the current, or to make the complete circuit. The trackless-trolley car is steered like an automobile. Its trolley poles are so constructed that they swing sideways easily, thus allowing the car to maneuver through traffic and to stop at the curb for passengers to board or leave the car.



TRACKLESS TROLLEY CAR.

The trackless trolley car was first introduced in Berlin, Germany, in 1899. In America, it was first demonstrated in Boston in 1901. The early cars had solid rubber tires, stiff springs and were not as comfortable as cars that run on rails. These defects were remedied, however, and starting in 1928 the new vehicles were put in regular service in Salt Lake City, where 26 are now in daily use. The Chicago Surface Lines adopted the trackless trolley car for "feeder service" in 1929. It proved popular and in 1931 this company was operating 114 of them. This is the largest number used by any one company. Following their introduction in Chicago, the new cars were placed in service in Rockford and Peoria.

"Feeders" Aid City's Growth:

The trackless trolley car and the gasoline motor coach are valuable as "feeders" for electric railway lines, and they are operated for this purpose by many local transportation systems.

In the development of a city there are areas which are so sparsely settled that the number of street car passengers would not warrant the expense of building and operating a street car line. To provide transportation service for the people who live in these areas, motor coach or trackless trolley car service is often used. These lines usually connect with a street car line, for which they are called "feeders."

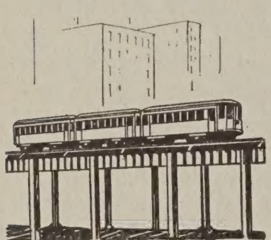
The result of establishing feeder service in an area is to attract more people to it. As homes are built, and businesses are established, the population increases until there is enough riders to

warrant the building of a street car line, for nothing has been found that equals the modern electric railway car for moving large numbers of people rapidly, comfortably, safely and with the least street congestion.

In a few small towns the motor coach is taking the place of the electric cars. Had the motor coach been invented when these towns first required better transportation than horse-drawn vehicles, the electric lines would not have been built there. For in these smaller communities, unlike the larger cities, there is no traffic congestion that makes electric railways essential.

Start of Rapid Transit:

Two vital factors in local transportation have been developed with the rapid growth of the world's largest cities. These are the *elevated lines* and the *subways.* These two transportation factors have given us the term—*"rapid transit,"* which literally describes them. As cities grew and spread out over large areas, it soon became apparent that some other quick means of transporting thousands of workers long distances to the downtown area were needed, in addition to the street cars. To attain high speed without adding to street congestion was the problem.



ELEVATED RAILWAY.

Engineers met this problem by building steel and wood structures on girders above the street levels. These were the elevateds, which have large platforms and stations conveniently located and connected to the street level by stairways. The cars are larger and heavier than the street cars. They are equipped with high speed motors, power for which is taken from the third rail. The cars are connected, often as many as eight cars to the train. The right-of-way often is wide enough for long stretches to permit use of four tracks, providing both "local" and "express" service. Above the street level, and therefore free from congestion caused by other vehicles, the elevateds are noted for their high-speed operation, making the connection of the extreme city limits of a city like Chicago, a matter of minutes rather than hours, as in the early days of the horse car.

Just as the elevated provides rapid transit above the street level, so does the subway furnish high speed service below the street level. The subway consists of tracks laid in tunnels. There is no waste of space in the use of these tunnels, or subways. Like the elevateds, the equipment draws its power from the third rail and is operated at high speed, with many cars comprising a train. Fixed schedules are maintained by both elevated and subway systems. Speed in loading and unloading at stations is obtained through building the platforms on a level with the car doors, thus abolishing the slow process of mounting and dismounting on car steps.

The first subway in America was opened in 1897 in Boston. In 1899, the first multiple-car trains were used in this subway, establishing it as the first underground rapid transit line in America.

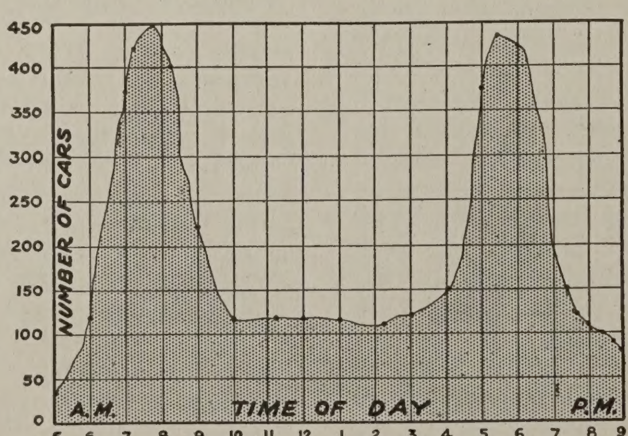
Rapid transit service is now supplied in Chicago, New York City, Boston and Philadelphia.

The Rush Hour Problem:

Twice a day, with the exception of Sundays and holidays, the local transportation companies of America's larger cities are faced with a tremendous problem. These daily occasions are known as the "rush hours," during which the great throngs of people working in the business districts, or the "downtown," of the city, must be brought to their work from all parts of the city early in the morning and returned to their neighborhoods late in the day. Because most people go to and return from their work about the same hour each day, transportation companies must provide facilities—such as cars and men—to meet these sudden large demands for instant transportation.

Most of the cars used are idle except during the rush hours, and working hours must be provided for the trainmen so that large forces will be on duty during rush hours, and smaller forces at other times. An illustration of this big problem is represented by the chart on this page. This chart represents a transportation company of a large city compelled to use a maximum of 450 cars in its rush hours and applies particularly to all industrial communities. The gradually-lessening number of cars actually necessary to handle traffic at hours of the day other than the "rush-hours" is indicated by the decline between the two *"peaks"* on the chart.

The chart shows that at 5 a. m. only 30 cars are needed. At 6 a. m. the people are starting to work and 120 cars must be on the lines. By 7 a. m. the great rush starts and 390 cars are needed. At 7:30 a. m. the *"peak"*



CAR SERVICE DIAGRAM FOR TYPICAL CITY ELECTRIC RAILWAY, ILLUSTRATING THE LARGE NUMBER OF CARS NECESSARY TO CARE FOR RUSH-HOUR TRAFFIC.

is reached and 450 cars must be in operation. Although this rush lasts less than an hour, this extra equipment must be available all of the time. By 9 a. m. 210 cars will haul all passengers wanting transportation and by 10 a. m. 120 cars are sufficient. From 10 a. m. until about 4 p. m.—six hours—only 120 cars are needed, as compared with 450 cars during the ''rush'' hours, and the rest are idle.

About 4 p. m. the shoppers start home and again the idle cars start coming out of the *barns* —a term of the horse car days which still remains today—with their crews. By 5 p. m. 360 cars are needed and by 5:30 the number must be 435 cars. These cars are needed only about half an hour, for by 6 p. m. the demand has been reduced to 420 cars, and by 7 p. m., when most of the workers are home for the evening meal, only 180 cars are in operation. By 8 p. m. the demand has dropped to but 90 cars. From that time until 5 a. m. the next morning the number drops gradually from 90 to 30 cars in service.

By advertising in cars, on posters, billboards, and in newspapers, local transportation companies today are trying to educate the public into certain riding habits which will relieve the rush hours. For example, shoppers, theater-goers, and sightseers, are urged to use the electric cars between the hours of 10 a. m. and 4 p. m. for their missions. As these are the hours when traffic is lightest, persons riding at that time are assured of getting their errands done quickly and without adding to the great crowds which feature the ''rush'' hours.

Everything possible is done to keep the cars moving and on time. In Chicago, the street railway companies keep trucks on hand which are equipped with special bodies and apparatus capable of coping with the various obstructions which may appear on their tracks. Over 60 per cent of the delays to street cars in Chicago are caused entirely by breakdowns of other vehicles, fires—making it necessary to lay hose across the rails —and other similar causes over which the electric railway operators have no control.

Interurbans Connect Cities:

An important development in the electric railway industry has been the interurban railroad. These interurban electric railroads are operated over private right-of-way in most cases. Well-ballasted roadbeds, on which heavy rail is laid, permit use of a heavy, large and fast type of equipment, elaborately equipped to provide for greater comfort on the longer trips furnished by the interurban. The interurban cars of today have roomy seats, smoking compartments, and other modern devices enhancing comfort and convenience.

Interurban cars are equipped with powerful motors and are geared for speed. Cities, towns and communities quite remote from one another have been connected. City workers are now enabled to own their homes in the country, or in suburbs, and commute swiftly and comfortably via the interurban to their offices.

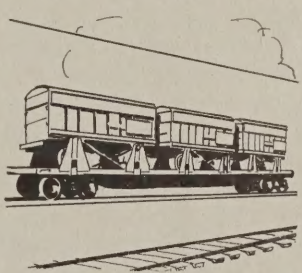
Small towns and cities and farming communities are now inter-connected by 17,500 miles of interurban lines.

The rapid introduction of the *interurban,* beginning in 1894, saw the Middle West and Illinois leading the country. Today, Illinois has the largest electric interurban system in the world—it operates in the central portion of the state. It has, also, the three fastest electric interurbans in America, all entering Chicago.

Two interurban electric railway companies which operate in Illinois, have coordinated their service with airplane lines, so that passengers may purchase one ticket and make part of their journey on the railway and the remainder in the air. As these companies also operate motor coaches, they are now rendering a complete transportation service.

While the great service of the electric interurbans has been in the transportation of passengers, they are also performing a great public service in their high speed methods of moving freight. Each year this is becoming a more important part of their service.

Some Illinois interurban electric lines use special refrigerator cars in their freight service. Refrigeration machines, instead of ice, cool these cars. Thus electricity, obtained from the trolley wires, not only moves the train but provides uniform, dry, and continuous cold in the refrigerator cars.



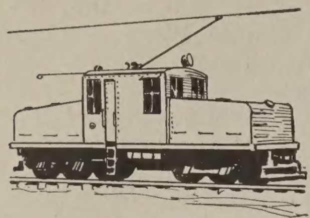
FREIGHT SEMI-TRAILERS.

Another innovation in the freight service of many Illinois electric interurbans is the use of flatcar semi-trailers for handling ''door-to-door'' freight shipments from city to city. These trailers, holding at least eight tons, are loaded in one city by the shipper, sealed and then mounted on flatcars without the trailer wheels being removed. The merchandise is thus shipped without being touched en route and without re-handling at the freight houses. This saves both time and expense and provides a convenient service to the customer, who does not have to use a truck to call for his goods at the station.

Steam Electrification:

So noiseless and efficient is electric operation that several steam railroads are using it in city terminals and on mountain divisions, thus eliminating smoke, increasing traffic, increasing speed of trains and reducing delays and operating costs. A notable example of this is the Illinois Central Railroad Company, which has electrified its tracks in Chicago and suburbs.

The first practical use of electricity for steam railroad operation was in 1895, when the Baltimore and Ohio Railroad placed electric locomotives in tunnel service at Baltimore, and the New Haven Railroad equipped its Nantasket Beach line for electric operation.



ELECTRIC LOCOMOTIVE.

The Pennsylvania Railroad and the New York Central lines were pioneers in electrifying lines directly entering city terminals. By 1910 their New York City divisions were electrified. The Pennsylvania Railroad is electrifying its service between Philadelphia and New York City.

About 4,500 miles of track have been electrified in this country, an average of nearly 200 miles a year for the last 25 years. In track mileage over which electric operation has supplanted steam, the United States leads all other countries. Already there are electrified sections of steam roads in some 30 countries, with a total track mileage of more than 21,000 miles electrically operated.

How an Electric Railway is Operated:

Successful operation of electric railways requires teamwork—much the same as successful athletic teams. Close co-operation between workers is required. Each worker and each department must see that his part of the business functions, for if one part fails, the entire railway operation fails.

There are the workers who operate the cars, or trainmen. Shopmen inspect and repair the cars. Trackmen maintain the tracks and linemen watch and repair the overhead wires. Office workers keep records and so on—each job essential to the service. Over these workers is the supervisory force, which is responsible to the management that work be done correctly. The management is responsible to the owners or stockholders.

Maintenance forces are the "trainers" of the railway team. It is their work to keep the system in good working order. For this purpose there is an endless stream of supplies coming in and leaving the storerooms. Besides keeping the cars, or *rolling stock* (as they are called), on hand, the storekeeper of one of the large electric roads in Illinois says that he keeps in stock 15,000 different kinds of articles for the maintenance of the property, varying from a track spike to a complete railway motor.

SNOW SWEEPER.

The companies also have available a large organization of men and equipment during winter to combat heavy snow and sleet storms, and thus often are able not only to maintain service on their lines but also provide a cleared roadway for public use when no other traffic lanes are open.

Chicago Gets Early Start:

Having the largest street car system, the largest fleet of trackless trolley cars, the largest interurban electric railway system and the three fastest electric railways in the world, Illinois stands foremost in the development of electric transportation.

The great interurban system of the Illinois Terminal Railroad, connecting the southern and central portions of Illinois with St. Louis, leads the world in size. Throughout Illinois there are modern local transportation systems, but, most naturally, the largest of them center in and around Chicago.

Chicago's local transportation started in 1853, sixteen years after the city was incorporated. The first public carrier was an omnibus. Horse cars were operated on State Street, between Randolph and Twelfth streets in 1859. Cable car service was inaugurated in 1882. There were four miles of double track. The route was on State Street from 39th Street to Madison Street; east to Wab-

Important Historical Dates in the Electric Railway Industry

1821—MICHAEL FARADAY DISCOVERED ELECTRICITY COULD BE USED TO PRODUCE MECHANICAL MOTION.

1828—FIRST AMERICAN STREET CARS, DRAWN BY HORSES, APPEARED IN NEW YORK CITY.

1832—HENRY INVENTED THE FIRST ELECTRIC MOTOR.

1835—DAVENPORT DEMONSTRATED ELECTRICITY COULD BE USED TO DRIVE A CAR ALONG RAILS.

1838—ROBERT DAVIDSON PRODUCED THE FIRST ELECTRIC CAR TO MOVE ON A STANDARD GAUGE TRACK.

1841—HENRY PINKUS PATENTED THE IDEA OF USING RAILS AS CURRENT CONDUCTORS.

1855—EARLIEST FORM OF TROLLEY WIRE AND TROLLEY POLES USED.

1861—PACINOTTI INVENTED THE REVERSIBLE CONTINUOUS CURRENT DYNAMO.

1873—THE FIRST CABLE CAR IN AMERICA WAS INTRODUCED IN SAN FRANCISCO.

1879—SIEMENS, IN BERLIN, OPERATED THE WORLD'S FIRST PRACTICAL ELECTRIC RAILWAY LINE.

1880—STEPHEN D. FIELD FILED FIRST AMERICAN PATENT FOR A LINE AND OPENED FIRST AMERICAN LINE EXPERIMENTALLY.

1883—CHARLES J. VAN DEPOELE DEMONSTRATED FEASIBILITY OF DRAWING CURRENT FROM AN OVERHEAD WIRE.

1884—BENTLEY AND KNIGHT OPERATED AMERICA'S FIRST PRACTICAL ELECTRIC RAILWAY, IN CLEVELAND.

1888—FRANK J. SPRAGUE—CALLED THE "FATHER" OF ELECTRIC RAILWAYS—RAN A LARGE ELECTRIC RAILWAY AT RICHMOND, SHOWING COMMERCIAL POSSIBILITIES OF ELECTRIC TRANSPORTATION.

1899—TRACKLESS-TROLLEY BUS ORIGINATED IN BERLIN, GERMANY.

ash Avenue; north to Lake Street; and then west to State Street.

First Electric Railway:

In 1890, three years before the last cable lines were built, the first electric railway line was placed in operation. It was on 95th Street, between Stony Island Avenue and South Chicago. While the beginning was small, electric operation proved so efficient that in 1906, 16 years after its start, there was not a cable car left in Chicago. In this year, also, the last horse cars were taken from the streets.

In 1892 elevated railroads first made their appearance in Chicago. The first line, now a part of the present elevated system, extended from Congress Street to 39th Street. Additions were built in 1893 so that service was available to Jackson Park, the site of the World's Columbian Exposition. Soon another elevated line was built, running along Lake Street; and the present Metropolitan Division of the elevated lines followed.

At first, small steam locomotives hauled the trains on the elevated structure, but an electrically-operated intramural railroad at the Exposition had proved so economical and successful, that in 1895 the Metropolitan elevated lines inaugurated electric operation. The other lines soon were electrified, also. The Loop was built in 1897, connecting all of the "down town" terminals of the elevated lines.

One Big System:

One of the most important steps in the history of Chicago's local transportation was taken in 1914 when the Chicago Surface Lines was formed and all of the street car lines in Chicago were brought under one management and free transfers issued between the different lines. Free transfer privileges had been started on the elevated lines in 1913.

The present Chicago Rapid Transit Company was formed in 1924. It brought all of the elevated lines under a single management.

On July 1, 1930, Chicago voters approved an ordinance providing for combining the surface lines and elevated lines into one great system with transfer privileges. The Illinois Legislature had previously enacted laws making such a consolidation possible. As a result of the new ordinance, there have been several important extensions of street car lines, and other additions to Chicago's local transportation system, such as subways, are planned. Chicago is the first large city in the world to approve a plan for one large, coordinated transportation system.

Nation's Fastest Lines:

Several of the suburbs forming a part of the Chicago Metropolitan Area have their own local transportation systems, and, in addition, radiating north, south and west from the center of Chicago are high speed electric railways which knit Chicago and its surrounding communities into one big Metropolis.

These electric railways—the North Shore Line, the South Shore Line and the Chicago Aurora & Elgin Railroad—are the three fastest electric railways in the United States. They carry both passengers and freight.

The importance of good transportation to Chicago is shown by the number of passengers they carry. Each week the elevated lines carry a number of passengers that exceeds the population of Chicago. In one week in 1930 they carried 5,164,697 people, and during a blizzard, March 27, 1930, they carried 1,008,929 people in one day, a new high record. The world's busiest railroad crossing is on the elevated lines at Lake and Wells Streets. As many as 218 trains, totalling 1,100 cars, pass this crossing in one hour.

Longest Car Line:

The Surface Lines carried 812,080,701 revenue passengers in 1930, and when the people who used transfers are included, there were more than 1,000,000,000 riders. Not only is the Surface Lines the largest street car system in the world, but it operates the largest fleet of trackless trolley cars.

Chicago has the longest street car line in the world, it extending 21 miles on Western Avenue between Howard Street and 95th Street.

A resident of Chicago in 1860 could ride only one mile for a fare; in 1932 a Chicago resident could ride 37 miles for one fare.

The people of Chicago averaged more than 300 rides each in 1931, and the total number of passengers on electric railways in the Chicago Metropolitan Area was 13 times the population of the entire United States.

THE WORLD'S BUSIEST ELECTRIC RAILWAY CROSSING AT THE INTERSECTION OF WELLS AND LAKE STREETS ON THE ELEVATED LINES OF THE CHICAGO RAPID TRANSIT COMPANY.

Illinois is Foremost:

It is claimed that no other part of the United States is so well supplied with electric interurban, local and supplemental transportation services as that portion of Illinois extending south from Peoria, and embracing the great industrial area around East St. Louis. These transportation facilities have had a pronounced influence on the development of the area, and especially on the region of East St. Louis.

When street car service was still a novelty, it was introduced in many of the cities of Illinois. It made life in these cities easier, and made them better places in which to build homes and establish businesses.

Lincoln's Partner Starts Line:

Springfield, the State Capital, was one of the first Illinois cities to have local transportation facilities. The first street railway, a short horse car line, was organized in 1866 by John Todd Stuart, a law partner of Abraham Lincoln. The first electric railway line commenced operations in 1890, and three years later all street car lines were electrified, and free transfers issued between them.

Many other Illinois cities have a similar local transportation history—first horse cars, and later modern street cars. As the history and development of most communities is closely identified with the growth of their local transportation systems—and in many instances, dependent upon them—it is an interesting study to trace the effect street railways have had upon the growth of various communities. It will be found, usually, that sub-divisions and new homes followed the establishing of new street car routes.

Most Cities Served:

At the present time, there are local transportation services in practically all Illinois cities large enough to warrant their operation.

While local transportation systems affected the growth of cities, interurban electric railways had a similar stimulating effect on entire regions, or districts, of Illinois. They knit together many individual communities, and made travel and commerce between them easy.

There are about 3,300 miles of electric railway track in Illinois at the present time. If placed in one line, these tracks would extend from New York to San Francisco.

Almost 2,000,000,000 passengers are carried annually in Illinois by the combined transportation facilities of the state's electric railways. The combined rolling stock of Illinois' electric railways totals more than 6,000 passenger cars, and more than 3,000 other cars and locomotives.

The Greatest System:

In 1906, an electric railway track was built beyond the city limits of Danville. This little line, serving a comparatively few people, was the start of the Illinois Traction System which expanded until it included Danville, Champaign, Urbana, Decatur, Bloomington, Peoria, Springfield and many intervening communities. As the system grew, its tracks were extended south to Granite City, and, with the completion in 1910 of the McKinley Bridge over the Mississippi River, the lines entered St. Louis. The McKinley Bridge was the first to cross an important stream exclusively for electric railway service.

While these developments were taking place, other electric railways were being built in and near East St. Louis, Alton, Belleville and Collinsville, supplying the residents of that territory intermediate service, and transportation to and from St. Louis over the Eads Bridge.

Pioneer in Improvements:

The Illinois Traction System was the first electric railroad to establish parlor and sleeping car service, automatic block signals, belt lines around cities for freight traffic, direct connections with mines, elevators and large industries, track connections and traffic relations with steam railroads and facilities for handling standard steam railroad cars. With these developments, the operation of the system became more and more like that of a steam railroad, and several such lines in and near East St. Louis were acquired. The name was changed to Illinois Terminal Railroad; elevated and underground tracks were built into the heart of St. Louis where a large terminal is under construction; and lines were improved by reduction of grades, heavier rails and heavy ballast.

THE MCKINLEY BRIDGE ACROSS THE MISSISSIPPI RIVER AT EAST ST. LOUIS IS THE LARGEST BUILT EXCLUSIVELY FOR ELECTRIC RAILWAY TRAFFIC.